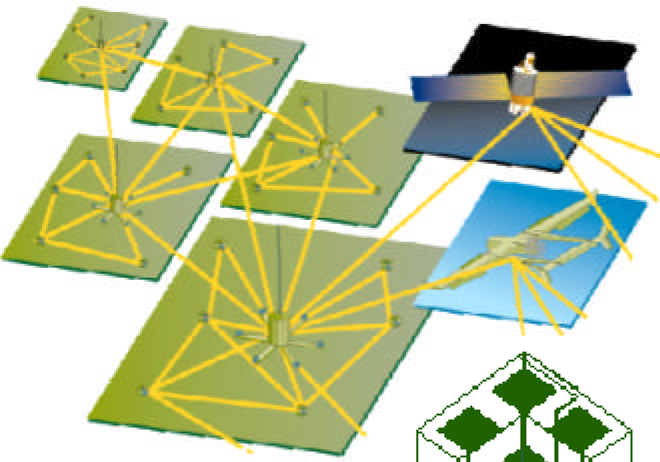
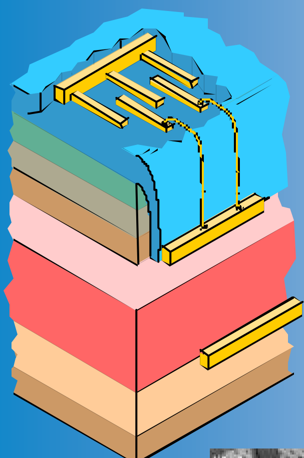
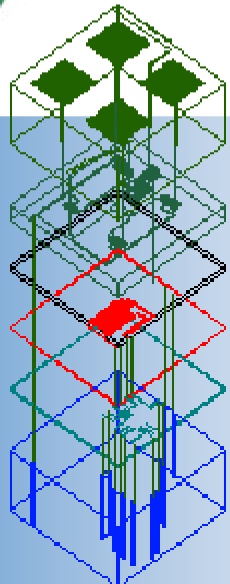
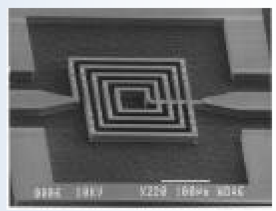
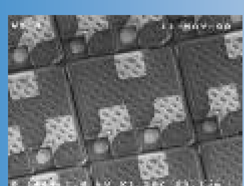










Advanced Sensors

Collaborative Technology Alliance

Dr. Dan Beekman
ARL Collaborative Alliance Manager

Mr. Steve Scalera
Consortium Manager, BAE SYSTEMS, IEWS

Advanced Sensors Collaborative Technology Alliance

Consortium Partners

- BAE SYSTEMS
- Northrop Grumman
- DRS Infrared
- Quantum Magnetics
- General Dynamics Robotic Sys
- U. New Mexico
- Clark-Atlanta
- MIT
- U. Maryland
- Georgia Tech
- U. Michigan
- U. Florida
- U. Mississippi
- U. Illinois – Chicago
- JPL

Objectives

Technologies that increase sensor performance and utility, and techniques to combine many types of data to provide timely and meaningful information to the soldier.

Affordable sensors that provide:

- Continuous situation awareness
- Rapid, precise detection and ID of camouflaged targets
- Environmental sensing for navigation and self-defense

Technical Areas

- Microsensors
- Electro-Optic Smart Sensors
- Advanced RF Concepts

Advanced Sensors Collaborative Technology Alliance

ARL CAM: Dr. Dan Beekman
BAE PM: Mr. Steve Scalera

Microsensors

ARL: Nino Srour
BAE Systems: Mark Falco

- Multi-Target Detection, Classification, & Tracking
- Multi-sensor Fusion Architecture
- Autonomous Sensor Management
- System Performance & Analysis

EO Smart Sensors

ARL: Arnie Goldberg
BAE Systems: Parvez Uppal

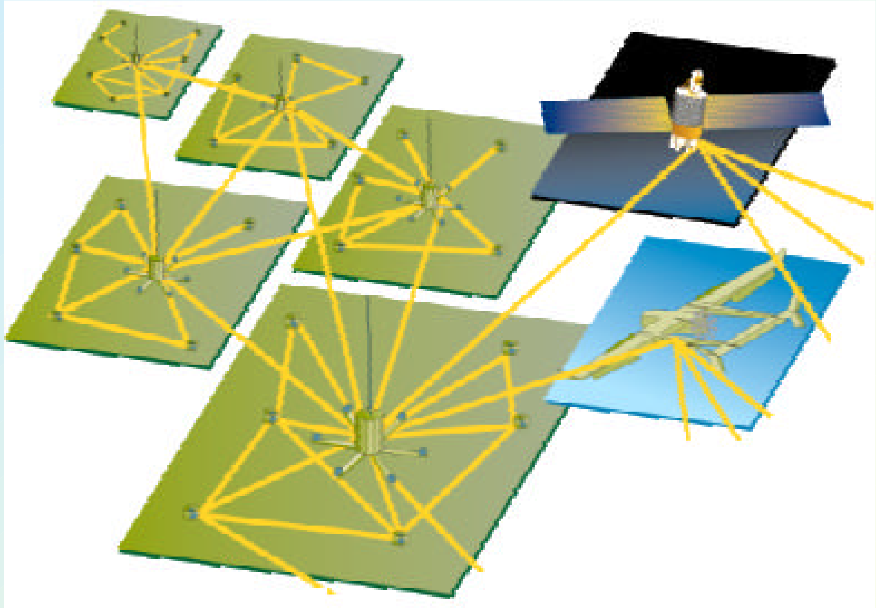
- High Operating Temperature FPAs
- Innovative Components for Ladar
- Hyperspectral Imaging Components
- ATR and Image Fusion

Advanced RF Concepts

ARL: Ed Viveiros
BAE Systems: Norm Byer

- Devices and Materials
- Electronically-Scanned Antennas
- Receivers and Waveform Generators
- Systems Study

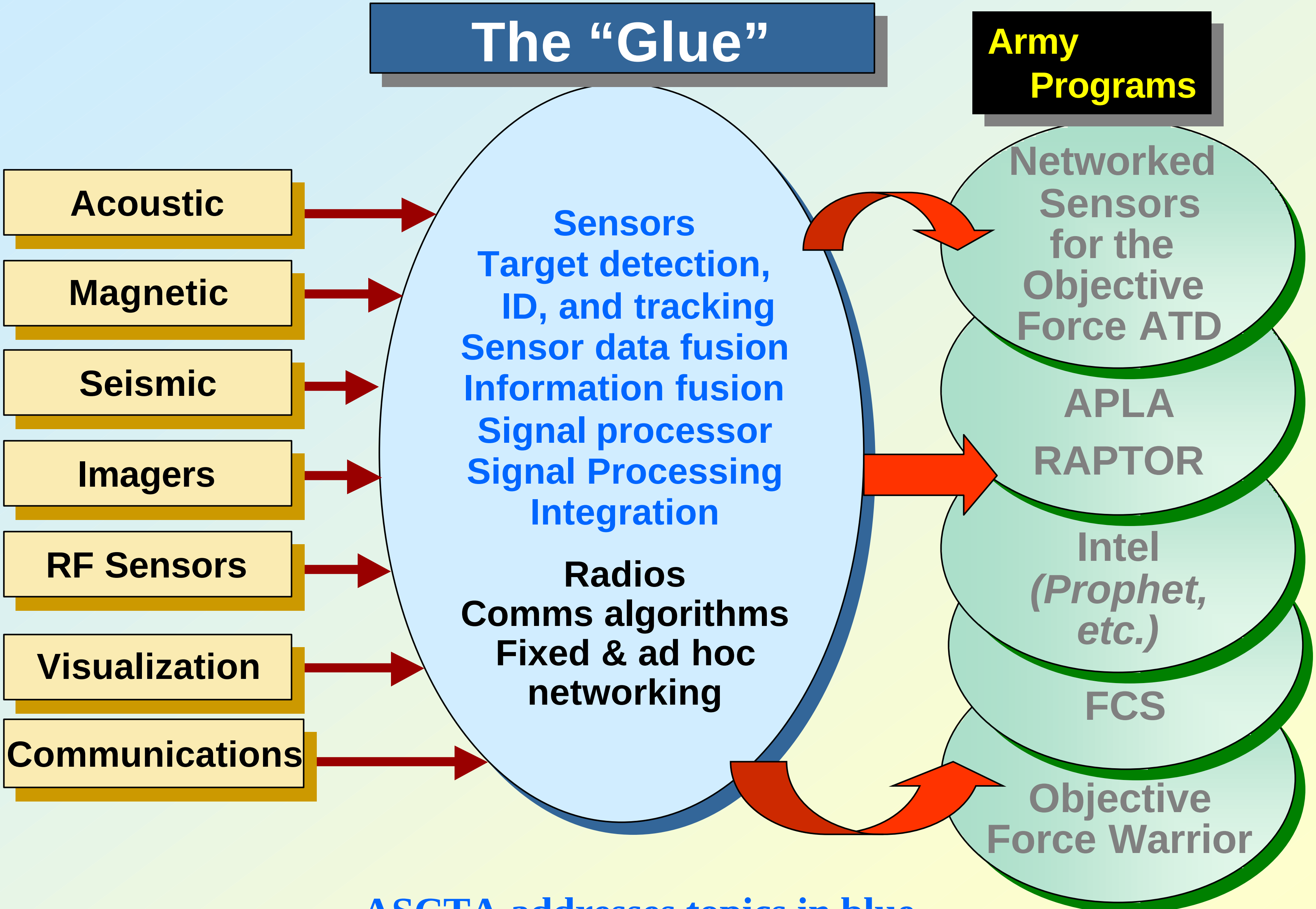
Networked Microsensors



Technical Area Leads:

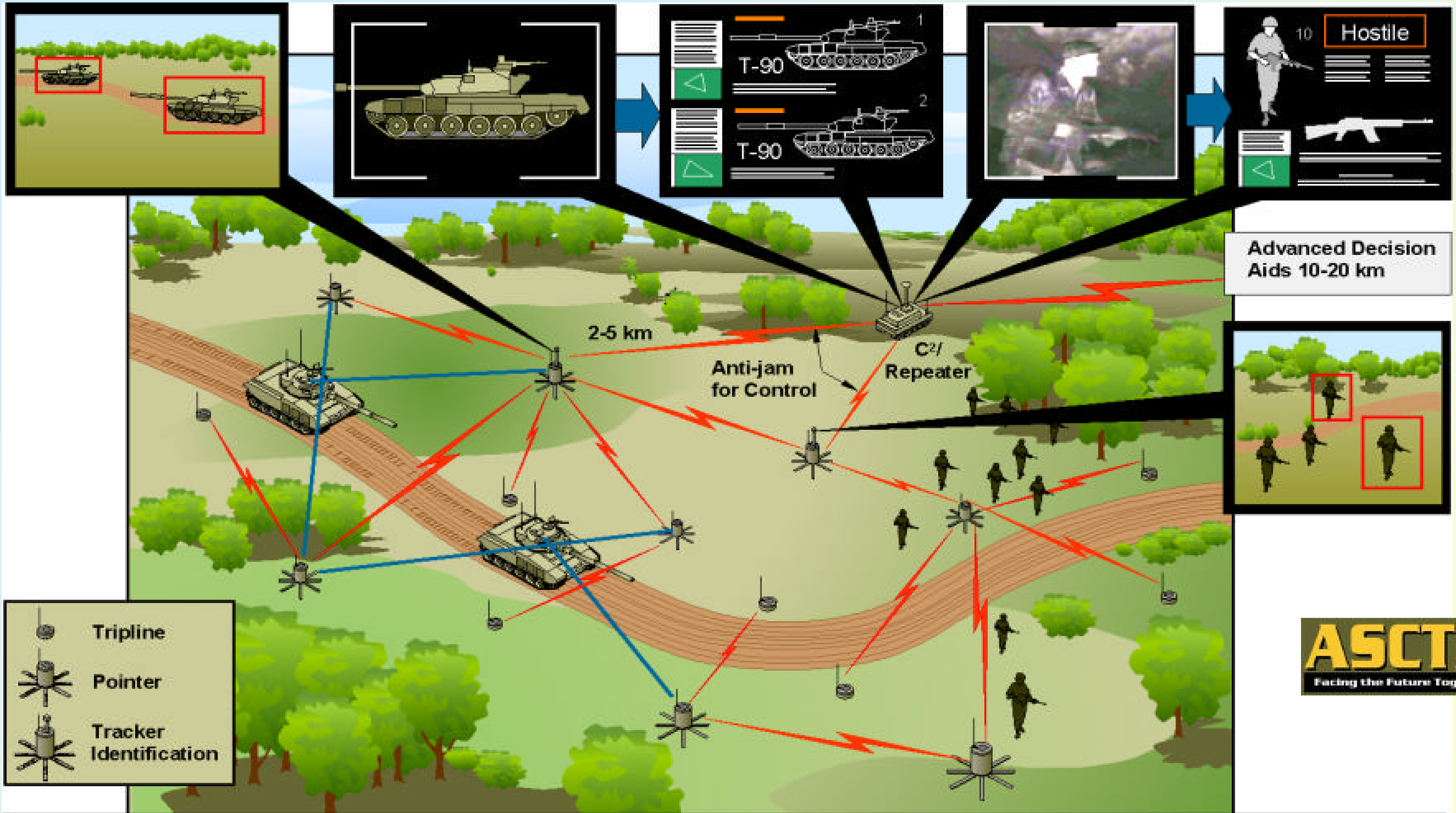
Nino Srour, ARL
and
Mark Falco, BAE SYSTEMS

Army Networked Sensor Efforts



ASCTA addresses topics in blue

Notional
Networked Microsensor System



- Self-localizing and calibrating sensor fields
- Very low power signal processing techniques to provide high throughput computation at nodes
- Fusion of data, features and decisions for robust performance and greatly reduced false alarm rates
- Hiearchical network with intelligent control to preserve power, reduce communication bandwidth and remove operator overload.
- Multi-sensor, multi-modal(imaging and non-imaging) low cost sensors for all weather performance
- Advanced algorithms for multi-target discrimination, tracking and identification of people and vehicles

Multi-Target Detection, Classification, Tracking

- Provide all weather wide-area detection, classification and tracking of multiple targets, including personnel and vehicles, within size, weight, and power constraints consistent with distributed micro sensor systems.
- Investigate multiple sensor modalities to improve performance.

FY03 Projects

- MS-03-01 Integrated Multi-Target Signal Discrimination and Classification Algorithms (BAE SYSTEMS)
- MS-03-08 Detection, Classification and Tracking of Multiple Humans/Vehicles using Distributed Imagers (UMD)
- MS-03-09 Robust Adaptive Signal Processing for Random Array Deployment (Georgia Tech)

Multi-Sensor Fusion Architecture

- Develop a modular, scalable, and robust fusion architecture under constrained bandwidth conditions.
- Investigate data, feature, and information level fusion across all levels of the system hierarchy.

FY03 Projects

- MS-03-19 Architectures for Decentralized Data Fusion Using Sufficient Statistics (BAE SYSTEMS)

Autonomous Sensor Management

- Develop algorithms for autonomous resource allocation of sensors to optimize system performance.
  - Including handoff, cueing, power management and performance improvement (Pd, Pcc, tracking error).
- Enable rapid deployment of the objective networked micro sensor system while allowing supervision of large areas of hostile terrain with minimum personnel.

FY03 Projects

- MS-03-04 Decentralized Sensor Management for Optimization of Unattended Ground Sensor Networks (CAU)
- MS-03-13 Sensor Network Self Calibration (OSU)
- MS-03-05 Precision Emplacement of Unattended Ground Sensors (GDRS)

System Performance and Analysis

- Conduct system studies, modeling and simulation for the purpose of optimizing overall network performance, cost, operating life and bandwidth usage.
- Derive sensor performance requirements by balancing fusion, cost, power and communication objectives.
- Investigate new sensor modalities and sensor improvements.
- Investigate low power/energy techniques, methodologies and tools for efficiently implementing complex algorithms.

FY03 Projects

- MS-03-06 Sensor Network Performance Evaluation (JPL)
- MS-03-07 Investigation of Wind Noise Mechanisms and Reduction (U Miss.)
- MS-03-11 RF Microsensor Design and Performance Enhancements (U Fla.)
- MS-03-12 Distributed Signal Processing for Microsensors with Comms (MIT)
- MS-03-18 Performance of Electromagnetic Microsensors (Quantum Magnetics)
- MS-03-21 Low Power Algorithms & Design Automation for Microsensors (U. Md)

Microsensors Roadmap

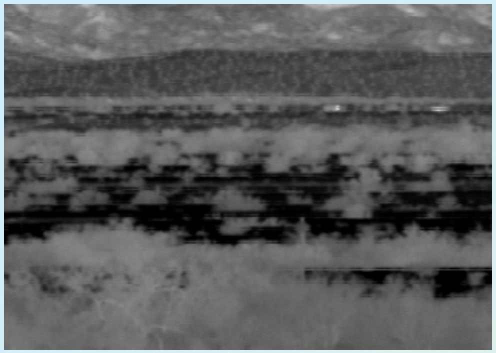
	Sept 01	Sept 02	Sept 03	Sept 04	Sept 05 / OUTYEARS
Multi-Target Detection Classification Tracking	Single sensor Multi-Vehicle Detect	Acoustic/IR Multi-Vehicle Detect, Track	Cluster level Multi-Vehicle, People Detect, Class, Track	Multi-Cluster Multi-Vehicle, People Detect, Class, Track	Multi-Network X-Platform Extended Operating Cond. Multi-Vehicle, People Detect, Class, Track
Multi-Sensor Fusion		Fusion Architecture definition	Cluster Level Fusion For D, C, T	Multi Cluster Fusion For D, C, T	Multi Platform Fusion UGS/UGV/UAV For D, C, T
Autonomous Sensor Management		Self Calibration	Cluster Level Management for Performance/Power	Multi-Cluster Level Management for Performance/Power	Fully Autonomous Sensor Management for Performance/Power
	Precision Emplacement				
Sensor development and Improvement	Advanced Electro-Magnetic Sensors				
	Multi-Function Micro RF sensors				
	Acoustic Wind Noise Cancellation				
Networked Sensors System Analysis, Modeling & Simulation	Node & Cluster Modeling & Simulation		Multi-Cluster Modeling & Simulation		Overall System Improvements
	Distributed processing in highly constrained networks				
	Low Power Algorithm	HW Code Gen.	Low Power Software Code Generator Tools		
Experiments and data collections					
Technology Maturation					End-to End system
Detect Classify Track	D,T	D,C,T	D,C,T	D,C,T	
Targets	Single Target	Multi Vehicle	Multi Vehicle	Vehicles, People	
Sensors	Single Sensor	Multi-Mode	Multi-Mode	Multi-Mode	
Fusion	No Fusion	Node Level Fusion	Cluster Level Fusion	Intra-Cluster Fusion	
Expected TRL	TRL 4	TRL 4-5	TRL 5	TRL 5-6	TRL 6
Transition Opportunities		ARDEC/NVESD TPA	NVESD NSfOF ATD/FCS	FCS/OFW	FCS/OFW
Milestones		Multi-Vehicle D,T Cluster	Multi-Vehicle D,C,T Multi-Cluster	Personnel D,C,T Cluster	Demonstration of multi-target [people, vehicle], multi-sensor, multi-platform networked sensor system in a relevant environment
			(End to End Algorithm suite)		

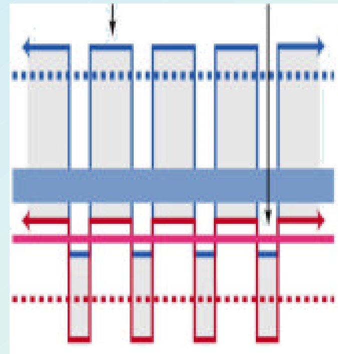
MIT OSU GT JPL CAU NGC BAE GDRS QM UFL UMD UMISS

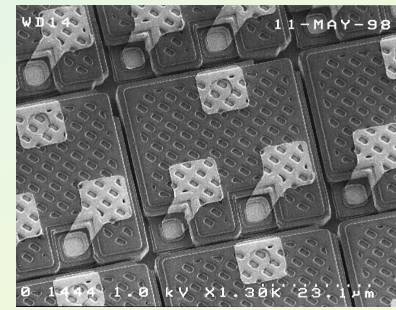
FY03 Project Summary

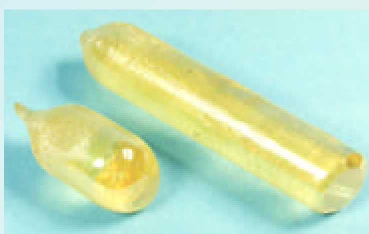
MS-03-01	Integrated Multi-Target Signal Discrimination and Classification Algorithms	M. Falco (BAE SYSTEMS) Shelby Sullivan (BAE SYSTEMS)
MS-03-03	Multimodal Sensor Fusion	Mark Hischke (Northrop Grumman)
MS-03-04	Decentralized Sensor Management for Optimization of Unattended Ground Sensor Networks	Dr. Lance Kaplan (CAU) Dr. Peter Molnar (CAU)
MS-03-05	Precision Emplacement of Unattended Ground Sensors	Kevin Bonner, Brad Beeson Phil Cory (GDRS)
MS-03-06	Sensor Network Performance Evaluation	Loren Clare, Jay Gao (JPL) Nino Srour (ARL)
MS-03-07	Investigation of Wind Noise Mechanisms and Reduction	Richard Raspet, Henry Bass (U Miss)
MS-03-08	Detection, Classification and Tracking of Multiple Humans/Vehicles using Distributed Imagers	Rama Chellappa and Qinfen Zheng (Univ of MD) Sandor Der (ARL), Mark Falco (BAE)
MS-03-09	Robust Adaptive Signal Processing for Random Array Deployment	J. McClellan, Russ Mersereau (GaTech), Shelby Sullivan (BAE)
MS-03-11	RF Microsensor Design and Performance Enhancements	Jim Kurtz (University of Florida)
MS-03-12	Distributed Signal Processing for Microsensors with Communication and Power Constraints	A. Chandrakasan, A. Oppenheim (MIT)
MS-03-13	Sensor Network Self Calibration	Randy Moses (OSU), Tien Pham (ARL)
MS-03-18	Performance and Functionality of Electromagnetic Microsensors	Yacine Dalichaouch, Alex Perry, Peter Czipott (QM), Alan Edelstein (ARL)
MS-03-19	Architectures for Decentralized Data Fusion Using Sufficient Stats	Dr. Edward Real (BAE)
MS-03-21	Low Power Algorithms and Design Automation for Micro Sensors	K. J. Ray Liu and S. S. Bhattacharyya (U MD) Mark Falco (BAE Systems), Andree Filipov (ARL)

EO/IR Smart Sensors



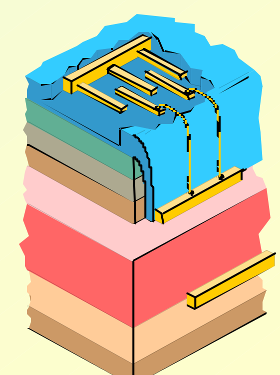






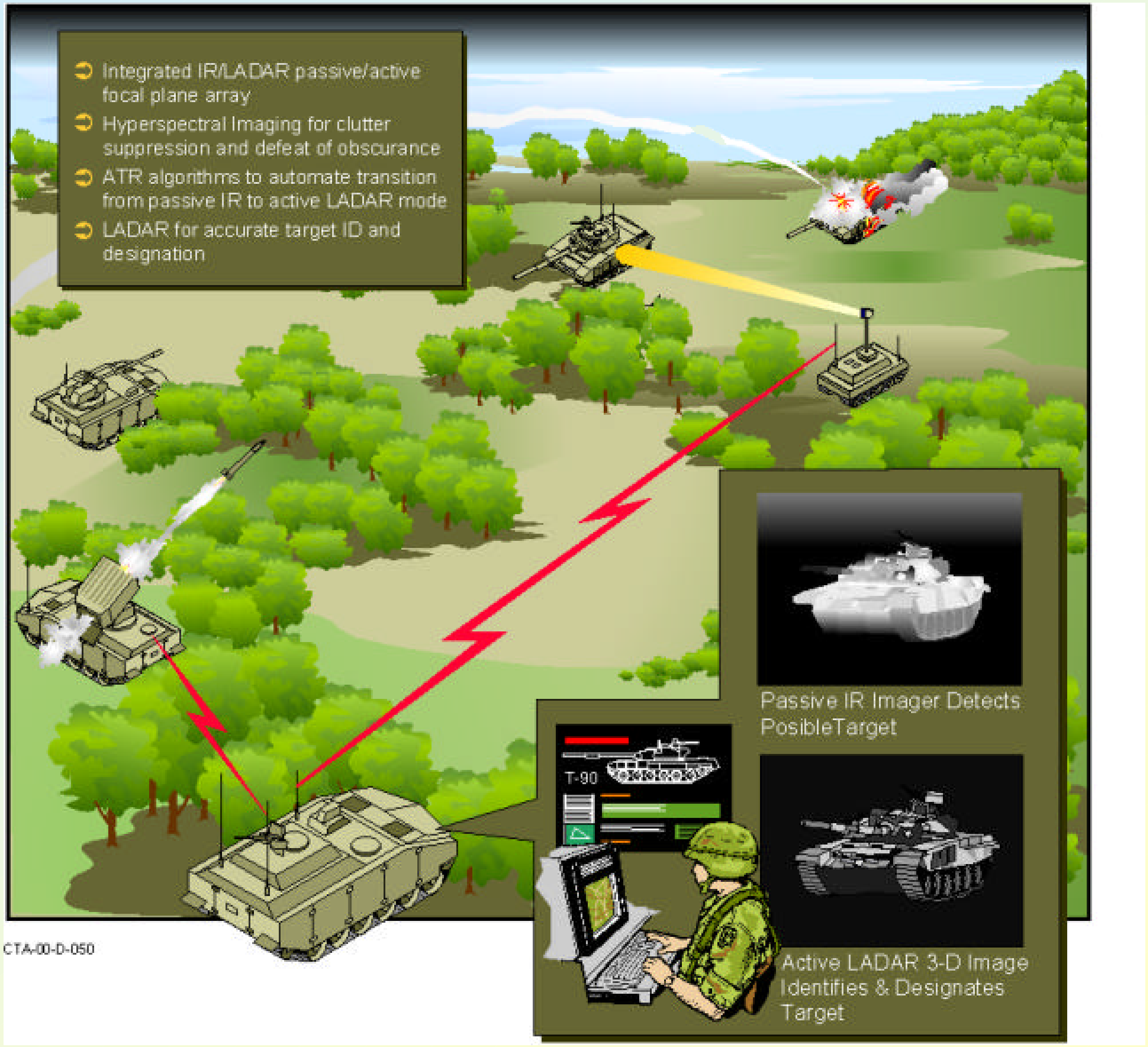
Technical Area Leads:

Arnold C. Goldberg, ARL
and
Parvez N. Uppal, BAE SYSTEMS



EO Smart Sensors Technical Area

The objective EO sensor will integrate target detection, identification, and targeting functions into one system

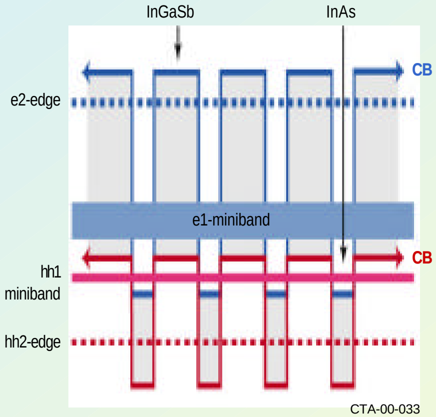


Component Development for Passive Imaging -

- Three approaches materials for development of higher operating temperature IR focal plane arrays
- Novel multifunction readout electronics

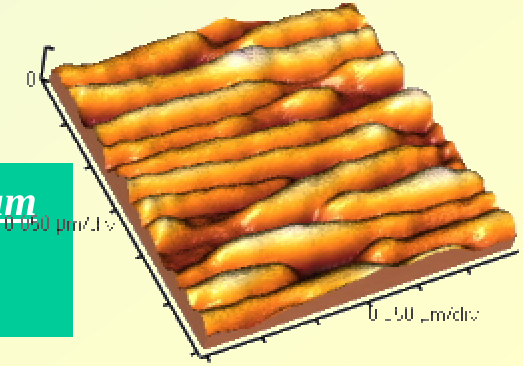
FY03 Projects

- HgCdTe defect reduction (U. Illinois - Chicago , DRS Infrared)
- GaInSb/InAs strained layer superlattice photodetectors (BAE SYSTEMS, U. New Mexico)
- Self-assembled quantum dots (U. New Mexico)
- Advanced active/passive readout circuits – U. Delaware (seed)



Antimonide-based Superlattice IR Dectectors

InAs Quantum Dots and Dashes

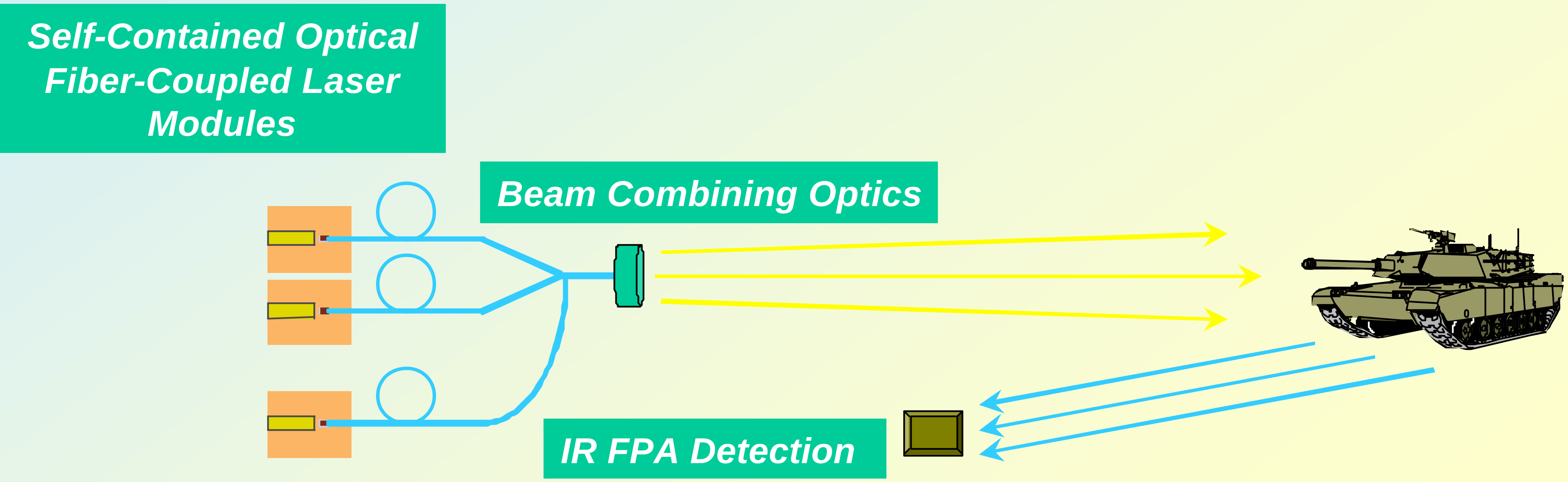


Component Development for Active Imaging

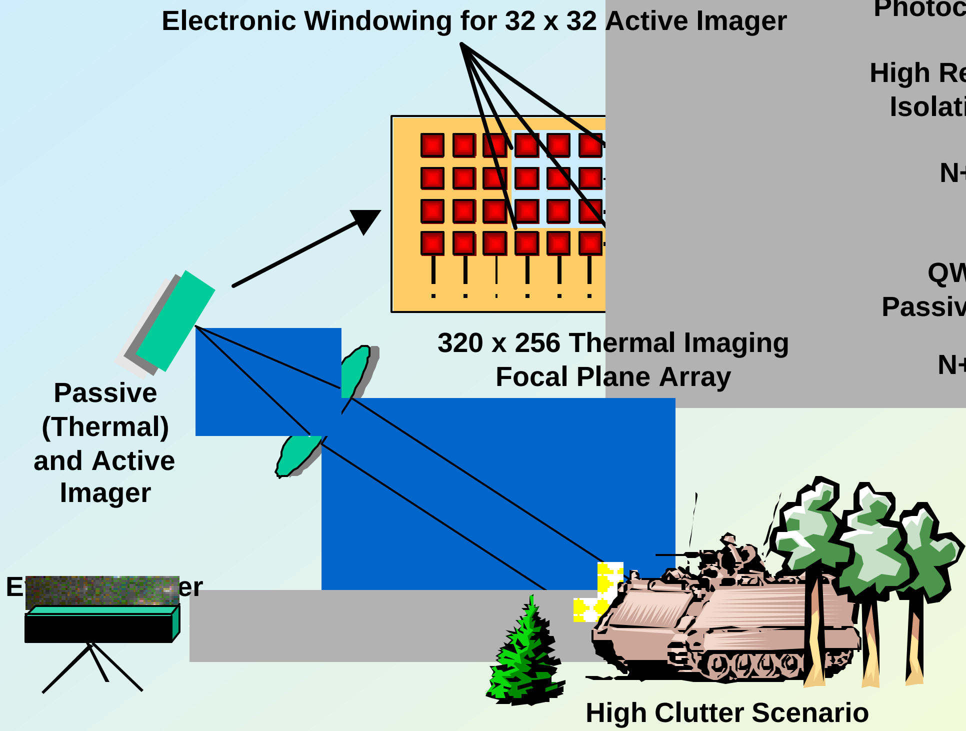
- Eye-safe laser development for FM/cw ladar

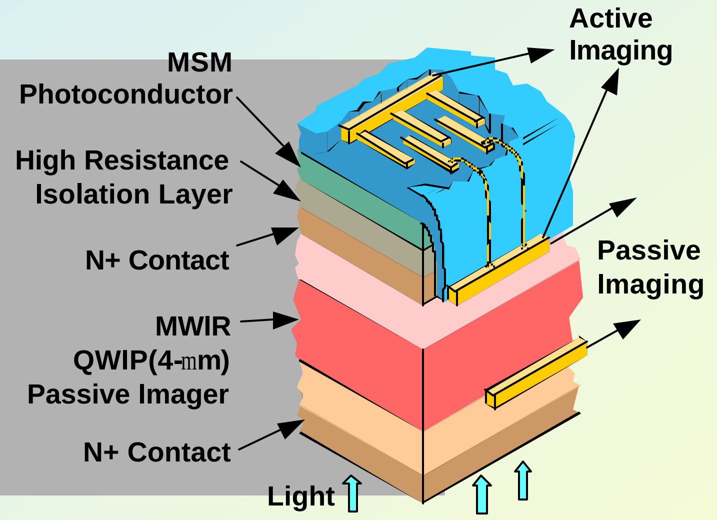
FY03 Projects

- Novel techniques for extending the wavelength of ladar sources (U. New Mexico)
- 2 – 5 micron laser development (Jet Propulsion Lab)



Integrated Active/Passive Imaging





CTA-00-034R2

The LWIR QWIP is at the bottom and will not absorb the 1.5 micron radiation. The 1.5 micron device is a MSM with low capacitance (~a few pF) for high frequency mixing.

- Combined passive/active device
- Multiple bands
- Windowed to reduce readout complexity and data stream requirements
- Pixel registered

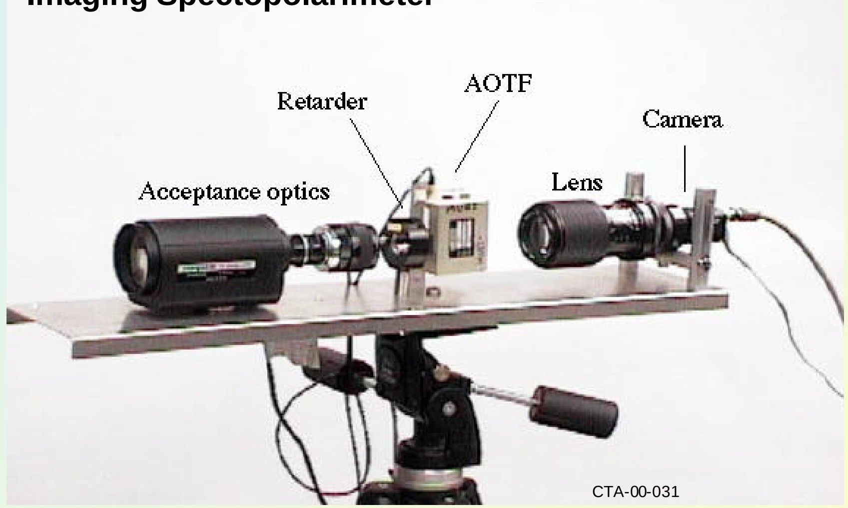
FY03 Projects

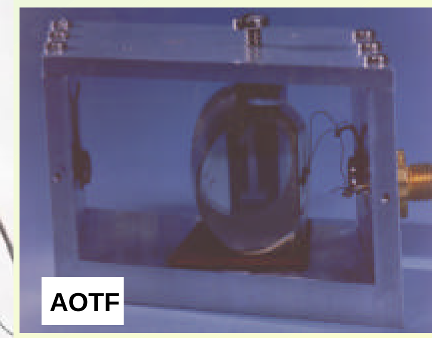
- Component Development for Integrated Passive and Active Imaging (BAE SYSTEMS)

Component Development for Hyperspectral Imaging

- Development of new acouto-optic crystals with high figure-of-merit complements the device development effort at ARL

Basic Components of AOTF Imaging Spectopolarimeter





FY03 Projects

- Process development and crystal growth of HgBr crystals for AOTF spectro-polarimetry (Northrop Grumman)

Algorithm Development for ATR and Multispectral/Hyperspectral Imaging

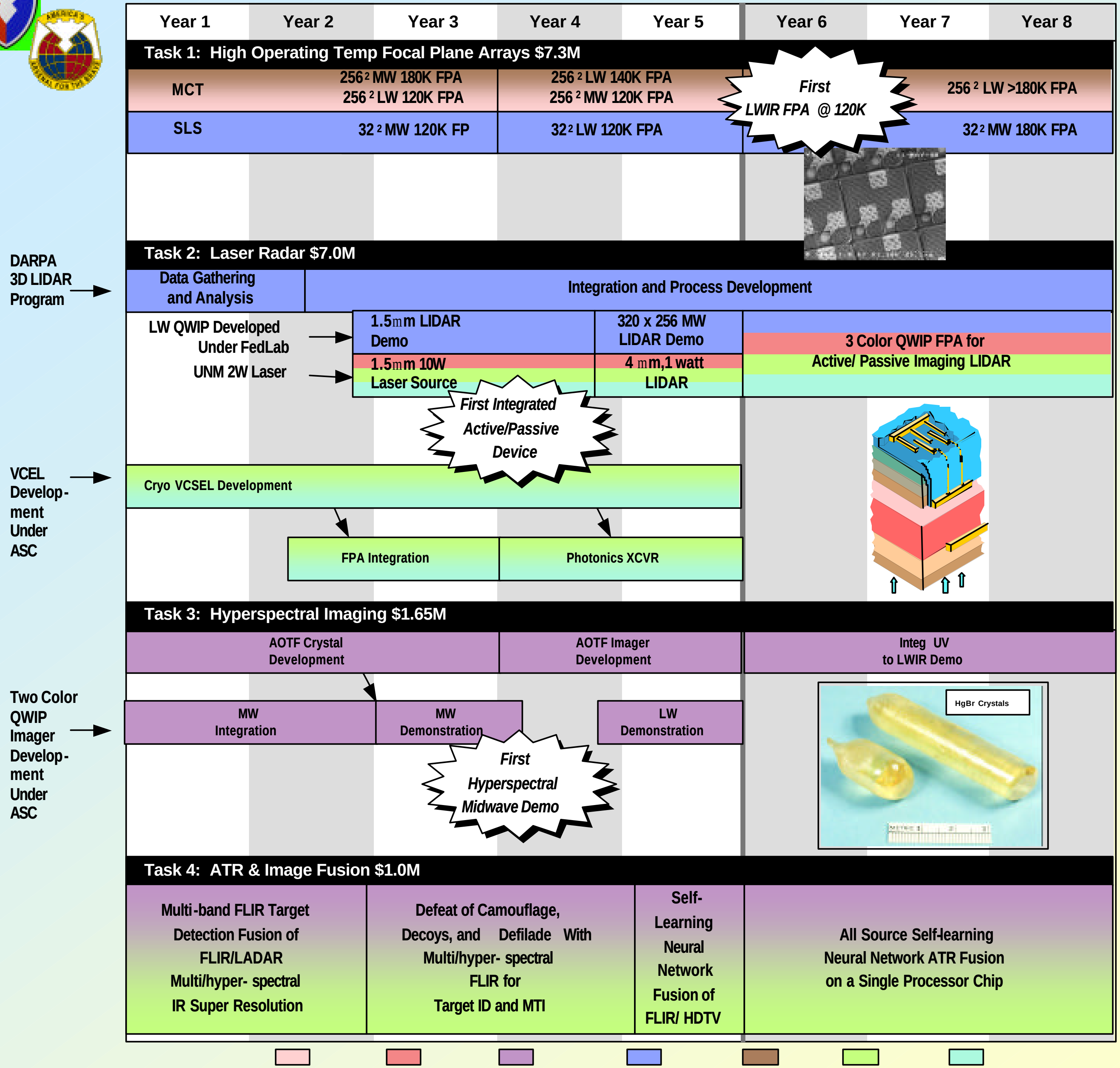
- Assess ATR/fusion algorithms and techniques for the types of sensors and platforms associated with Future Combat Systems
  - Enhanced target recognition in FCS operational scenarios
  - Image fusion for two-color IR
  - Tools for hyperspectral signature modeling

FY03 Projects

- ATR for dual-color infrared imaging (U. Maryland)
- Modeling tool development for realistic hyperspectral target signatures (Duke University) (seed project)

An input frame

Feature extraction



EO Component Development Roadmap

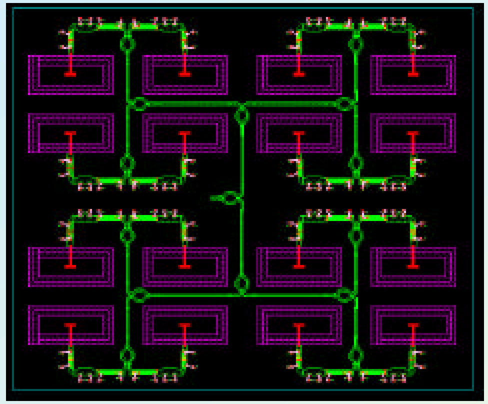
ASCTA

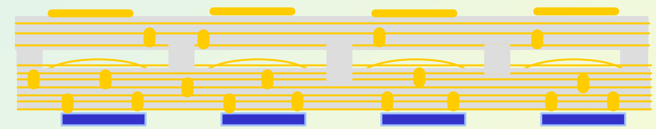
EO Smart Sensors

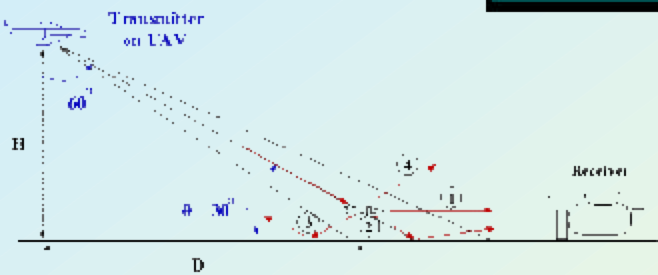
FY03 Annual Program Plan

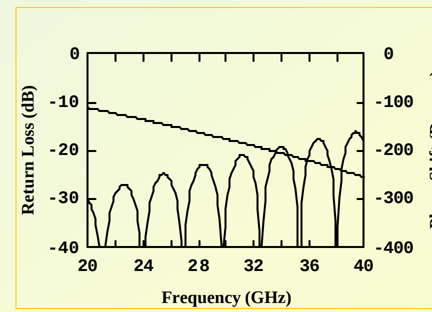
PROJECT	TITLE	PRINCIPAL INVESTIGATOR	k$
EO-03-01	Components for Active/Passive Imagers	Parvez Uppal (BAE SYSTEMS)	270
EO-03-02	GaSb-based Superlattice MW and LW Detectors	Parvez Uppal (BAE SYSTEMS)	100
EO-03-02b	Materials for GaSb-based Superlattice Detectors	Kevin Malloy (U. New Mexico)	110
EO-03-03	MCT Materials Development	Siva Sivananthan (UI-Chicago)	238
EO-03-04	Higher-Operating Temperature MCT FPAs	Hung-Dah Shih (DRS)	270
EO-03-05	Longer Wavelength Ladar Sources	Kevin Malloy (U. New Mexico)	190
EO-03-06	MWIR Quantum Well Lasers	Kamjou Mansour (JPL)	77
EO-03-07	ATR Algorithms for Dual-Color IR Sequences	Qinfen Zheng (U. Maryland)	70
EO-03-09	Components for IR AOTF Hyperspectral Imagers	N.B. Singh (Northrop Grumman)	77
EO-03-10	Low-Threshold VCSELs	Julian Cheng (U. New Mexico)	160
EO-03-12	Advanced Readout for Active/Passive Imagers	Fouad Kiamilev (U. Delaware)	100
EO-03-14	Modeling Tools for Hyperspectral Signatures	Larry Carin (Duke University)	150

ASCTA Advanced RF Concepts









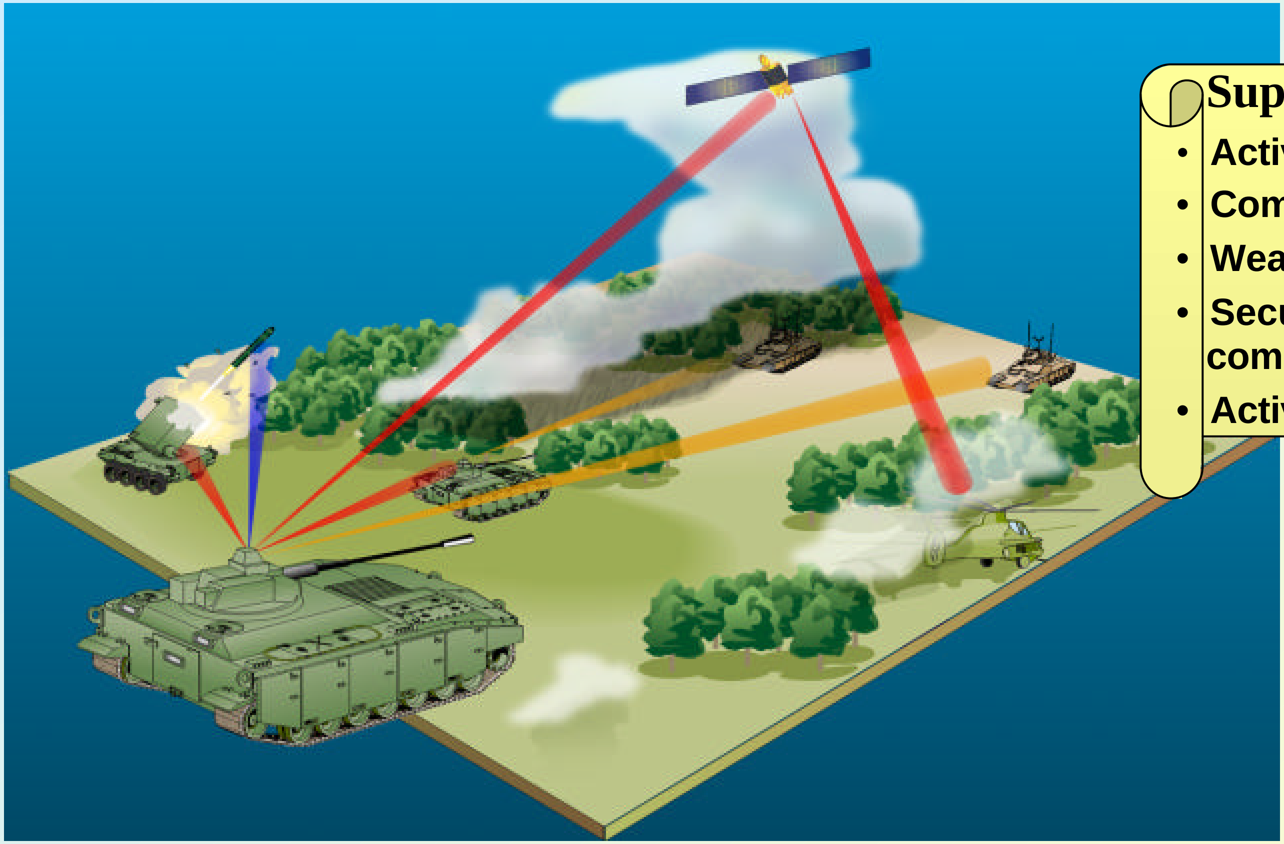
Technical Area Leads:

Ed Viveiros, ARL

and

Norm Byer, BAE SYSTEMS

Multifunction RF System

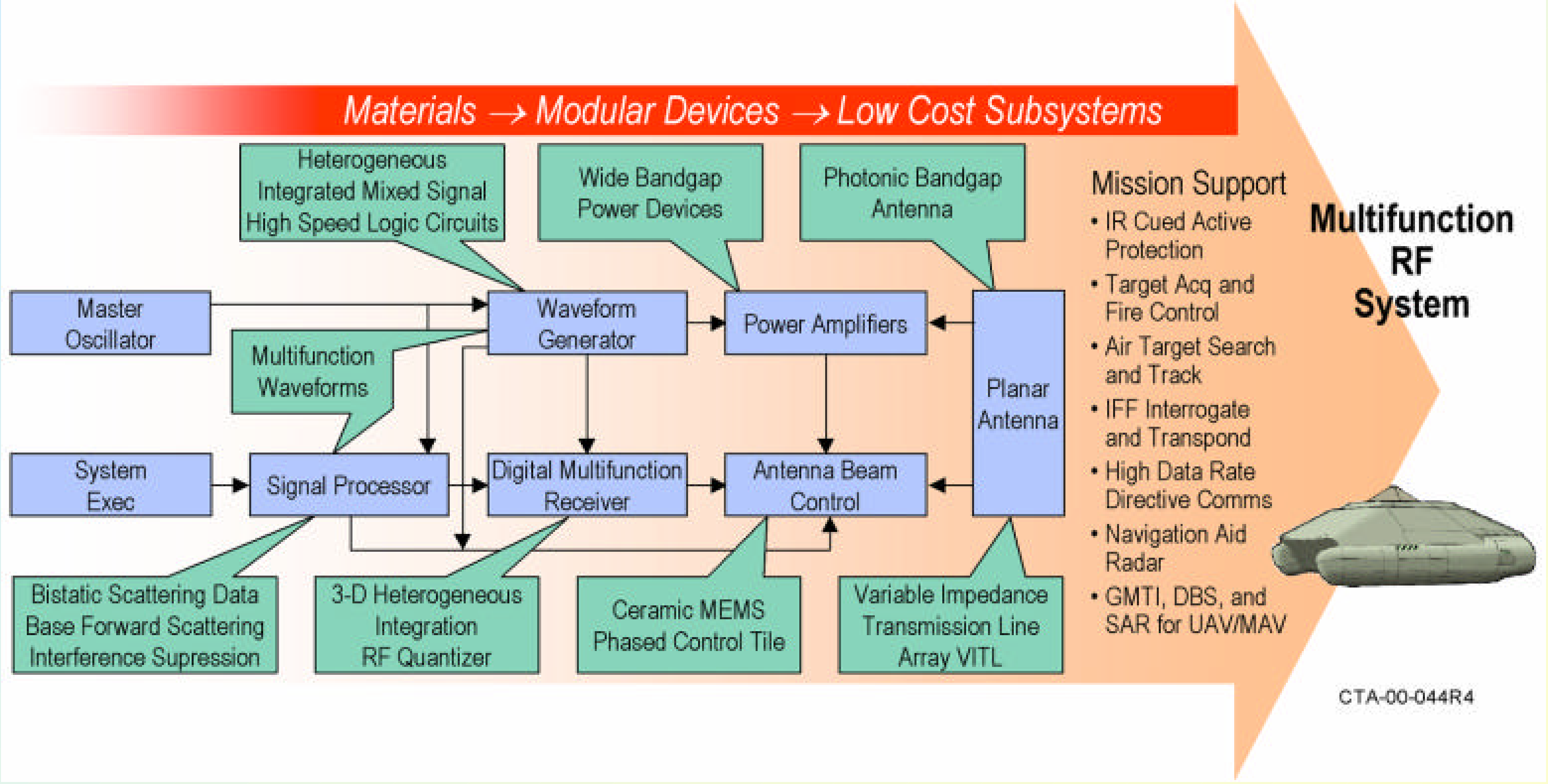


Supported Mission Needs

- Active/Passive Target Acquisition
- Combat Identification
- Weapons guidance
- Secure point-to-point communications
- Active Protection

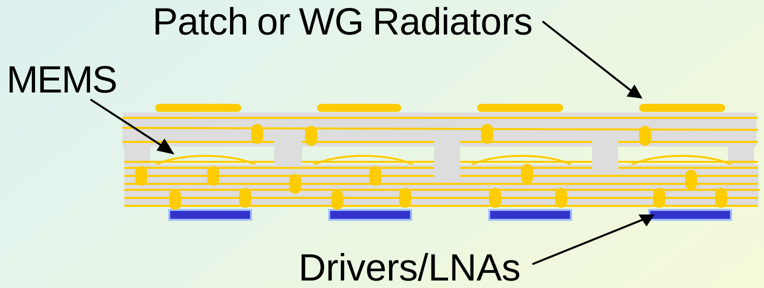
Focus on combining RF Functions in an affordable, modular architecture with a shared aperture for ground vehicle application. Support Future Combat System requirements.

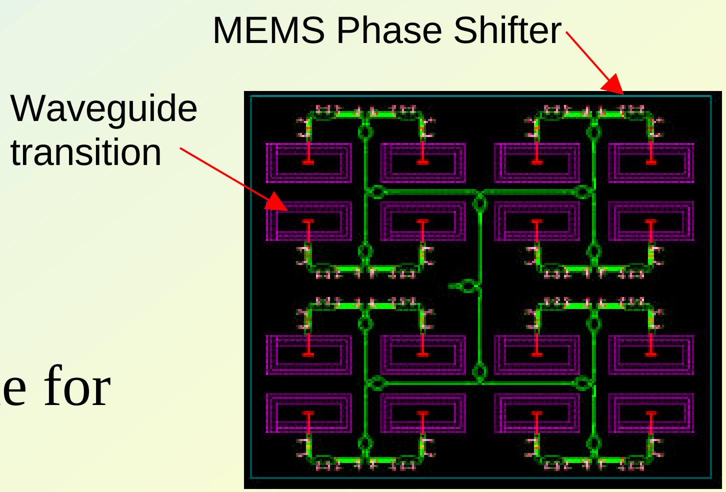
Advanced RF Concepts
Multifunction RF System Development



Low Cost Electronically Steered Arrays (ESA)

- Efficient, compact, and affordable phased array antenna technology
- Order of magnitude cost reduction over conventional approaches
- Modular and scalable





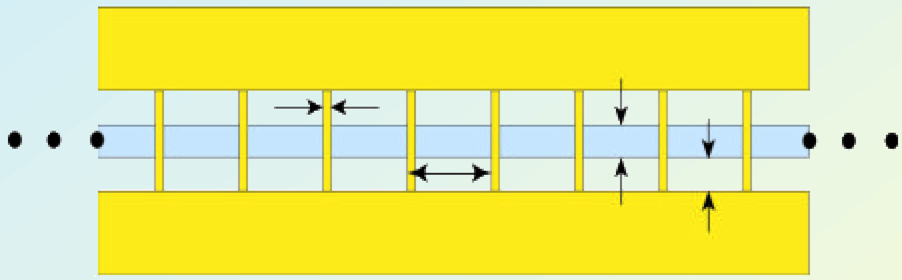
FY03 Projects

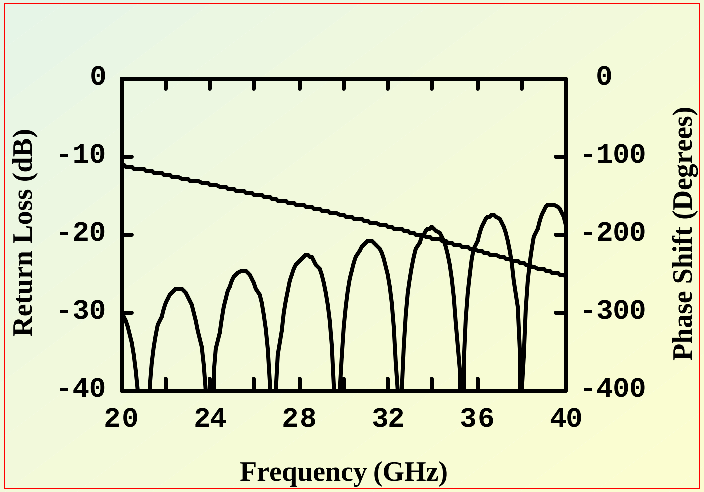
- RF-03-02 Integrated Phase Control Module for Ka-Band ESA (Northrop Grumman)
- RF-03-14 A Novel MMW Lens-Filter Array (University of Michigan)
- RF-03-17 Compact MMW Dual Polarized Multifunction Active Array Tech (U. Mich)

Devices and Materials

- Develop MEMS circuits using bulk silicon and surface micro-machining techniques that will be directly integrated with planar radiating elements
- Develop low loss GaAs pHEMT switches and phase control elements

Distributed MEMS Transmission Line



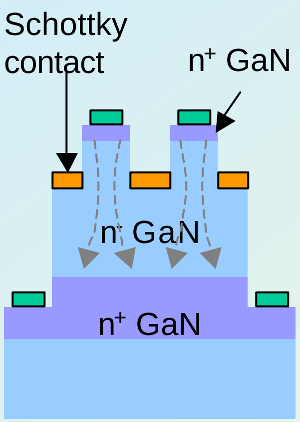


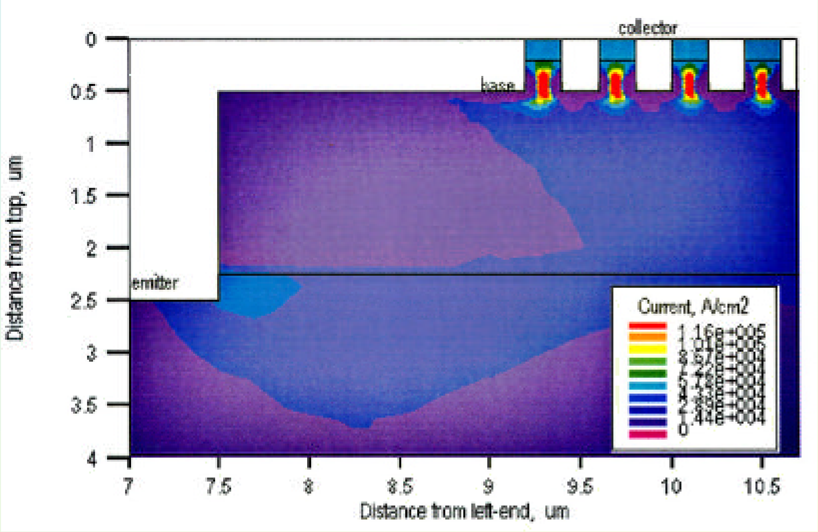
FY03 Projects

- RF-03-05 MEMS TTD Elements and Associated Packaging (U. of Michigan)
- RF-03-06 MEMS Device Reliability and Packaging (U. of Michigan)
- RF-03-16 LTG-GaAs Switch Device Fabrication and Test (BAE SYSTEMS)

Devices and Materials

- Advance Gallium Nitride (GaN) HEMT technology to provide 5W/mm power density at Ka-band



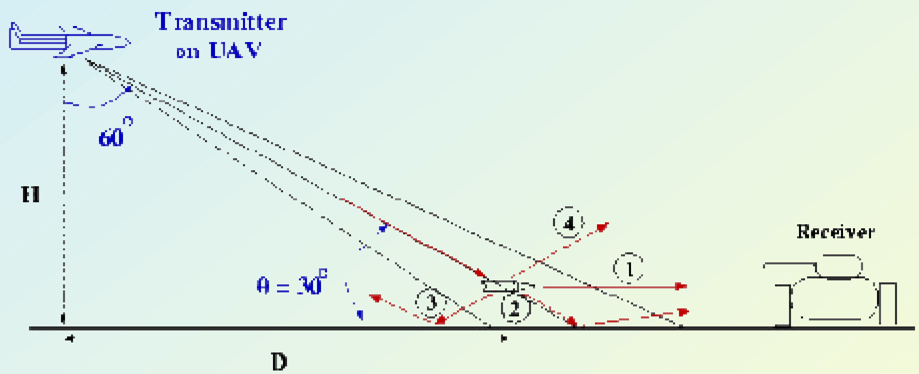


FY03 Projects

- RF-03-10 MMW GaN Material/Device Development (BAE SYSTEMS)
- RF-03-13 AlGaN HEMT Research for MMW Applications (Cornell)
- RF-03-12 InP-Based HBT Technology with On-Wafer Cooling (U. Michigan)

Systems Studies

- Develop understanding bistatic signal scattering for various types of terrain over a wide range of illumination and scattering directions
- Develop spatial and frequency diversity techniques to counter multipath-induced fading
- Design advanced digital waveforms that will provide parameter estimation and multifunction capability



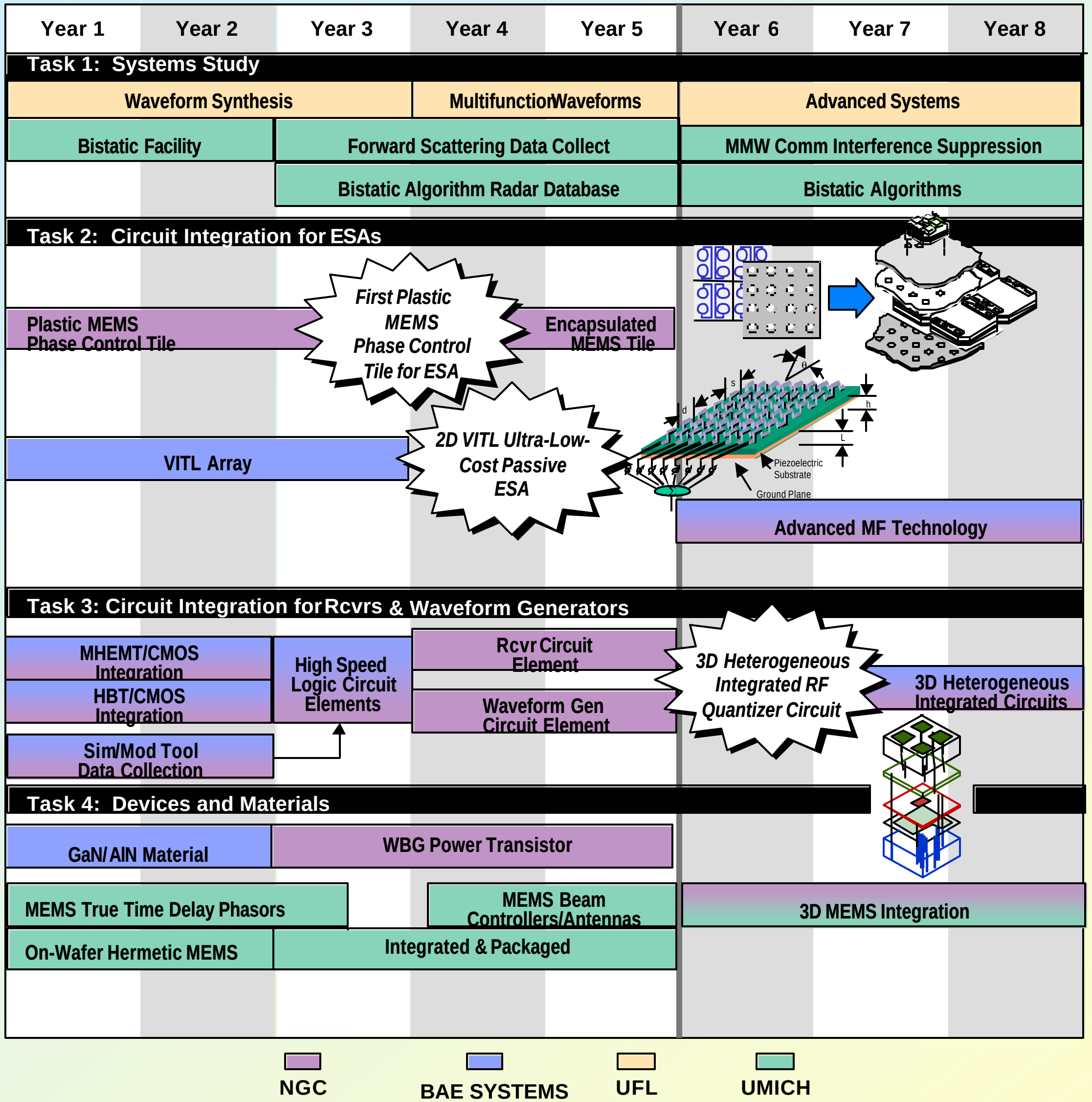
FY03 Projects

- RF-03-09 MMW Bistatic Scattering Phenomenology (University of Michigan)
- RF-03-04 Multifunction Radar Systems and Waveform Investigations (U. Fla)

RF FY03 Annual Program Plan

Topic #	*Research Topic*	*Principal Investigator*	*ROM Cost*
RF-03-02	**Integrated Phase Control Module for Ka-Band ESA**	**Norm Powell (Northrop Grumman)**	**$235k**
RF-03-04	**Multifunction Radar Systems and Waveform Investigations**	**Jim Kurtz (University of Florida)**	**$132k**
RF-03-05	**MEMS TTD Elements and Associated Packaging**	**Gabriel Rebeiz (UMich)**	**$110k**
RF-03-06	**MEMS Device Reliability and Packaging**	**Linda Katehi (UMich)**	**$110k**
RF-03-09	**MMW Bistatic Scattering Phenomenology**	**Fawwaz T. Ulaby (UMich)**	**$150k**
RF-03-10	**MMW GaN Material/Device Development**	**Ken Chu (BAE SYSTEMS)**	**$50k**
RF-03-12	**InP-Based HBT Technology with On-Wafer Cooling**	**Saeed Mohammadi (University of Michigan)**	**$75k**
RF-03-13	**AlGaN HEMT Research for MMW Applications**	**Lester Eastman (Cornell University)**	**$50K**
RF-03-14	**A Novel MMW Lens-Filter Array**	**Kamal Sarabandi (University of Michigan)**	**$70k**
RF-03-16	**LTG-GaAs Switch Device Fabrication and Test**	**Robert Actis, Kirby Nichols (BAE SYSTEMS)**	**$200K**
RF-03-17	**Compact MMW Dual Polarized Multifunction Active Array Technology**	**Amir Mortazawi (University of Michigan)**	**$70k**

RF Roadmap



Year 1
Year 2
Year 3
Year 4
Year 5
Year 6
Year 7
Year 8
Task 1: Systems Study
Waveform Synthesis
MultifunctionWaveforms
Advanced Systems
Bistatic Facility
Forward Scattering Data Collect
MMW Comm Interference Suppression
Bistatic Algorithm Radar Database
Bistatic Algorithms
Task 2: Circuit Integration for ESAs
Plastic MEMS Phase Control Tile
First Plastic MEMS Phase Control Tile for ESA
Encapsulated MEMS Tile
VITL Array
2D VITL Ultra-Low-Cost Passive ESA
Piezoelectric Substrate
Ground Plane
Advanced MF Technology
Task 3: Circuit Integration for Rcvrs & Waveform Generators
MHEMT/CMOS Integration
HBT/CMOS Integration
High Speed Logic Circuit Elements
Rcvr Circuit Element
Waveform Gen Circuit Element
3D Heterogeneous Integrated RF Quantizer Circuit
3D Heterogeneous Integrated Circuits
Sim/Mod Tool Data Collection
Task 4: Devices and Materials
GaN/AlN Material
WBG Power Transistor
MEMS True Time Delay Phasors
MEMS Beam Controllers/Antennas
3D MEMS Integration
On-Wafer Hermetic MEMS
Integrated & Packaged
NGC
BAE SYSTEMS
UFL
UMICH

Advanced Sensors CTA
Task Orders

Consortium Member	Sponsor	Task Order
Quantum Magnetics	ARL	Long-baseline Magnetic Gradiometer Investigation
BAE SYSTEMS	Network Sensors for the Objective Force ATD, CECOM	Development of a Low Power Modular Acoustic and Imaging Sensor (MAIS)
Pyramid Technologies, BAE SYSTEMS	ARL	Field Programmable Gate Array Signal Processor for a Ladar Test Bed, Phase 1&2
BAE SYSTEMS	ARL	Ka-band Metamorphic HEMT MMIC Development
BAE SYSTEMS	DARPA	UV Non-Line-of-Sight Communications Test Bed
BAE SYSTEMS	ARL	320×256 Two-Color LWIR/LWIR QWIP Focal Plane Array for NVESD Mine Detection
University of Illinois, Urbana	ARL	Investigate MMW Scattering from Rough Surfaces
University of Michigan	ARL	Create and Maintain Radar Clutter Databases